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CASE REPORTS

Echocardiographic Identification of an Aortic Valve Ring Abscess

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A valve ring abscess was diagnosed in four patients with a prosthetic aortic valve by identifying an echo-free space on two-dimensional echocardiography. Three of the patients presented with severe aortic regurgitation and congestive heart failure after an episode of endocarditis, but two of them did not have evidence of active endocarditis. The fourth patient had endocarditis, but no evidence of aortic regurgitation or heart failure. All four patients required valve replacement. Similar findings in all 11 previously reported cases suggest that a valve ring abscess can be diagnosed by two-dimensional echocardiography. It may be found without clinical evidence of endocarditis, in the absence of aortic regurgitation, without echocardiographically identifiable vegetations or during resolution of endocarditis.

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Echocardiography is a valuable technique in the diagnosis of infective endocarditis (1–3) and in the evaluation of prosthetic cardiac valves (4–7). Complications of native or prosthetic valve endocarditis, including leaflet degeneration, annular dehiscence and regurgitation, have also been recognized by echocardiography (1–7). There have been only a few reported cases (8,9), however, in which a prosthetic valve ring (perivalvular) abscess was suspected echocardiographically, and only a single case report (9) in which an echo-free space, representing the abscess cavity, was identified preoperatively.

During a 17 month period, from February 1984 to July 1985, we studied three patients who developed a valve ring abscess as a complication of prosthetic valve endocarditis and a fourth patient who had no evidence of endocarditis. In each case the diagnosis was made before cardiac catheterization or surgery by identifying an echo-free space on two-dimensional echocardiography. A brief description of our cases and a review of the literature will show that two-dimensional echocardiography can be useful in identifying a valve ring abscess.

Methods

Echocardiography

All patients were studied using a Hewlett-Packard two-dimensional echocardiograph with recording of parasternal long- and short-axis views, apical four and two chamber views and subcostal four chamber and short-axis views. All M-mode studies were derived from the two-dimensional image. Alterations in gain and reject settings were employed to optimally define the margins of the abscess cavity. Doppler echocardiography was performed in one of the patients.

Study Patients

The clinical features of the patients are summarized in Table 1.

Case 1. A 26 year old man with a history of intravenous drug abuse was admitted to Grady Memorial Hospital in February 1984 because of increasing shortness of breath, fever and fatigue. A Björk-Shiley aortic valve prosthesis had been inserted 9 months previously for aortic regurgitation secondary to endocarditis. Two months before admission, he had been seen in the outpatient clinic complaining of malaise and a persistent, nonpurulent cough. He was given tetracycline and took it intermittently over the next 6 weeks.

On admission, he was afebrile and had a blood pressure of 126/60 mm Hg with bounding arterial pulses. The cardiac apex was displaced 5 cm lateral to the midclavicular line and sustained. A grade 3/6 early decrescendo diastolic murmur was heard at the upper left sternal border and a third heart sound and Austin-Flint murmur were heard at the apex. Chest X-ray films showed cardiomegaly with bilateral interstitial edema. Normal sinus rhythm and first degree heart block were present on the electrocardiogram. Three sets of blood cultures were negative.

An echocardiogram revealed an echo-free space posterior to the aortic anulus, but no vegetations were seen (Fig. 1 and 2). Cardiac catheterization demonstrated moderate to

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Table 1. Summary of the Salient Clinical Features of Four Patients

Case	Aortic Valve Prosthesis	Chief Complaint	CHF	Severe AR	Cultures
1	Björk-Shiley	SOB	+	+	Negative
2	Carpentier-Edwards	Fever	+	+	*S. aureus*
3	Björk-Shiley	SOB	+	+	Negative
4	Hancock	Fever	—	—	*S. aureus*

AR = aortic regurgitation; CHF = congestive heart failure; SOB = shortness of breath; + = present; — = absent.

severe aortic regurgitation secondary to a periprosthetic leak, a pseudoaneurysm that originated from the posterior ascending aorta and a small left-sided diverticulum below the left anterior descending coronary artery. Excessive rocking of the Björk-Shiley valve was also noted.

At surgery the aortic valve prosthesis was dehisced for approximately 50% of its circumference and an abscess cavity, extending from just underneath the left coronary orifice to the right coronary artery, was identified. The aortic valve prosthesis was replaced with a new Björk-Shiley valve and the abscess evacuated. The patient's recovery was uneventful and a postoperative echocardiogram was normal.

He was readmitted in February 1985 with fungal endocarditis involving the new aortic valve prosthesis. A two-dimensional echocardiogram revealed a large aortic valve vegetation, but no evidence of an abscess cavity. At surgery, a vegetation was found adhering to the struts of the prosthesis, but no abscess cavity was seen. The Björk-Shiley prosthesis was removed and replaced with a Hancock bioprosthesis. After an uneventful postoperative course and a normal echocardiogram, he was discharged. He was again readmitted in September 1985 for another episode of endocarditis that required insertion of his third prosthetic valve. He is currently in the hospital receiving an extended course of antibiotic therapy to cover a wide variety of bacteria and fungi. Long-term prognosis is guarded.

Case 2. A 46 year old man was admitted to Crawford W. Long Hospital in February 1984 with fever and chills. One month earlier he had a Carpentier-Edwards aortic valve prosthesis inserted for aortic regurgitation and patch repair of a ventricular septal defect. His postoperative course was complicated by mediastinitis. Culture of the chest wound grew *Staphylococcus aureus* and enterococci, but blood cultures were negative and he was discharged well.

On admission, he had a temperature of 39°C and a blood pressure of 168/70 mm Hg with bounding arterial pulses. The cardiac apex was displaced 3 cm lateral to the midclavicular line and sustained. A systolic thrill was palpable in the third left intercostal space. A grade 4/6 diamond-shaped systolic murmur and a grade 2/6 early decrescendo diastolic murmur were audible at the base. Neither an Austin-Flint murmur nor a third heart sound was heard. Chest X-ray films showed cardiomegaly with clear lung fields and an electrocardiogram showed only atrial fibrillation. Three sets of blood cultures were negative.

A two-dimensional echocardiogram revealed a large vegetation and an echo-free space on the lateral wall of the aorta (Fig. 3). At surgery, a 1 cm valve ring abscess un-

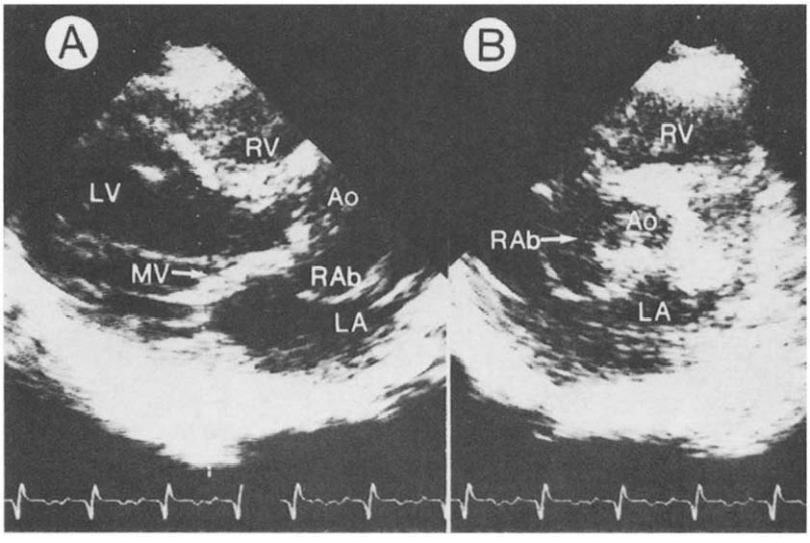

Figure 1. Case 1. Two-dimensional echocardiogram in a patient with a Björk-Shiley aortic valve prosthesis. **A**, Parasternal long-axis view in systole shows an echo-free space that corresponds to the valve ring abscess (RAb). It is posterior to the aortic (Ao) anulus and encroaches on the left atrium (LA). Valvular vegetations are not seen. **B**, Parasternal short-axis view shows that the valve ring abscess (RAb) involves the right coronary anulus. LV = left ventricle; MV = mitral valve; RV = right ventricle.

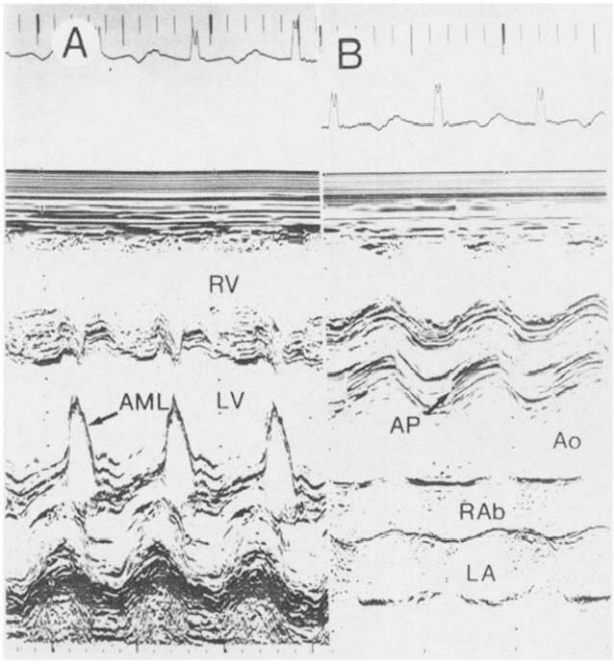

Figure 2. Case 1. M-mode echocardiogram. **A**, Dilated, hypercontractile left ventricle (LV) and the anterior mitral leaflet (AML) with high frequency diastolic fluttering characteristic of aortic regurgitation. **B**, Normal-appearing aortic prosthesis (AP) and the valve ring abscess (RAb) that encroaches on the left atrium (LA). Other abbreviations as in Figure 1.

derneath the left coronary ostium was identified as well as rupture of the patch used to close the ventricular septal defect. The septal defect was repaired, the abscess evacuated and the aortic valve replaced with a Björk-Shiley prosthesis. The patient was treated postoperatively with parenteral nafcillin, ampicillin and gentamycin and was discharged well 2 weeks later. Oral ampicillin and dicloxocillin therapy was administered for an additional 2 weeks. Several subsequent clinic visits were unremarkable.

Case 3. A 51 year old woman, on continuous ambulatory peritoneal dialysis, was admitted to Grady Memorial Hospital in January 1985 with increasing shortness of breath and melena. Six months before admission she had a Björk-Shiley aortic valve prosthesis inserted for idiopathic aortic regurgitation.

On admission, she was afebrile and had a blood pressure of 170/70 mm Hg with bounding arterial pulses. The cardiac apex was displaced 3 cm lateral to the midclavicular line and sustained. A grade 3/6 early decrescendo diastolic murmur and a grade 2/6 early diamond-shaped systolic murmur were heard at the upper left sternal border and a third heart sound and an Austin-Flint murmur were audible at the apex. A chest X-ray film showed cardiomegaly with clear lung fields. The electrocardiogram was normal. Three sets of blood cultures were negative, but Klebsiella and Enterobacteriaceae organisms were isolated from the peritoneal fluid.

A two-dimensional echocardiogram revealed excessive motion of the prosthetic valve suggestive of anular dehiscence and an echo-free space that extended from the posterior aortic valve anulus to the anterior mitral leaflet. No vegetations were seen (Fig. 4). A Doppler echocardiogram revealed severe aortic regurgitation. At cardiac catheterization, moderate to severe aortic regurgitation and a pseudoaneurysm arising in the sinus of Valsalva at the origin of the right coronary artery were demonstrated.

At surgery, the aortic valve prosthesis was dehisced and a large, burrowing, destructive abscess involving the aortic anulus and the noncoronary aortic cusp was identified. The aortic valve prosthesis was replaced with a Hancock bioprosthesis and the abscess evacuated. A repeat echocardiogram revealed a normally functioning prosthetic valve. The patient had a fatal cardiac arrest 7 days after surgery. Permission was not given for autopsy.

Case 4. A 25 year old man was admitted to Grady Memorial Hospital in July 1985 because of fever and altered

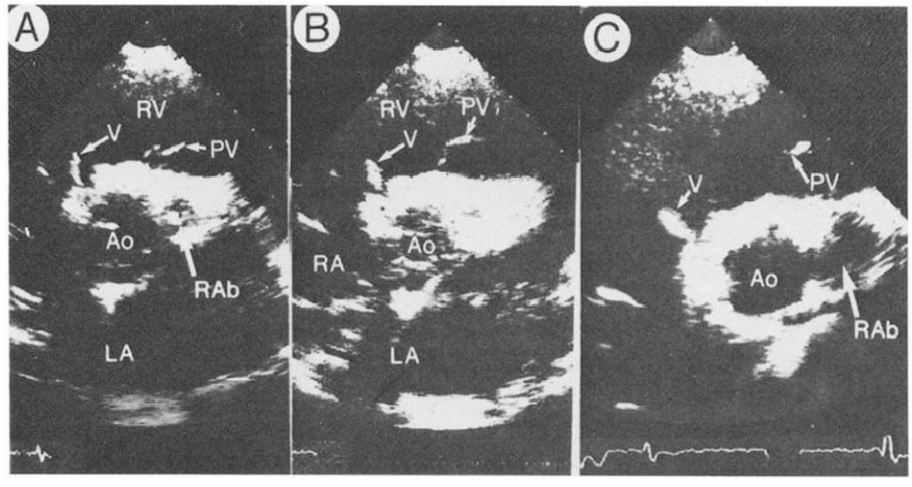

Figure 3. Case 2. Two-dimensional echocardiogram in a patient who has a porcine aortic valve prosthesis. **A** and **B**, Parasternal short-axis views in systole and diastole, respectively, show a vegetation (V) that protrudes from the aorta (Ao) into the right ventricle (RV). The echo-free space on the lateral wall of the aorta, best seen in the magnified image (**C**), is the valve ring abscess (RAb). PV = pulmonary valve; RA = right atrium; other abbreviations as in Figure 1. (Reproduced with permission of Felner and Knopf [3].)

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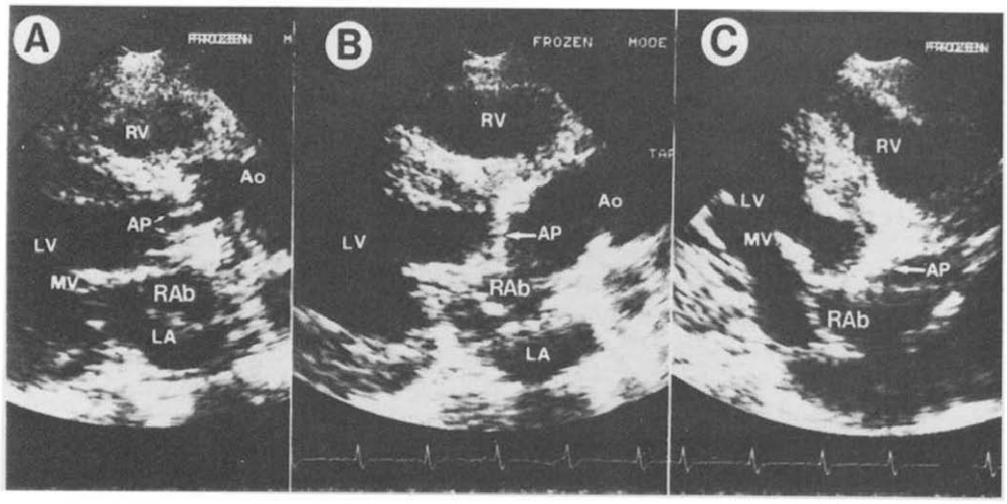

Figure 4. Case 3. Two-dimensional echocardiogram in a patient with a Björk-Shiley aortic valve prosthesis. **A** and **B**, Parasternal long-axis views show valve dehiscence as evidenced by rocking of the aortic prosthesis (AP) in systole (disc open) and diastole (disc closed), respectively. An echo-free space that represents the valve ring abscess (RAb) extends from the posterior aortic anulus into the anulus of the mitral valve (MV). **C**, Apical long-axis view shows the relation of the valve ring abscess (RAb) to the mitral valve (MV) and aortic valve prosthesis (AP). Other abbreviations as in Figure 1.

mental status. A Hancock aortic valve prosthesis had been inserted 2 years earlier for aortic regurgitation secondary to endocarditis involving a bicuspid valve. He had a "boil" on his back and began experiencing fatigue and dizziness 1 week before admission.

On admission, he had a temperature of 32.2°C and a blood pressure of 100/70 mm Hg. A conjunctival hemorrhage was present in the right eye. Jugular venous pulse, carotid pulse and apical impulse were all normal. Auscultation revealed only a grade 2/6 diamond-shaped systolic murmur at the base; no gallop sound was heard. The chest X-ray film was normal and the electrocardiogram showed only sinus tachycardia.

An echocardiogram on admission revealed a normally functioning bioprosthetic aortic valve and was otherwise entirely normal. Six sets of blood cultures grew *Staphylococcus aureus*. Treatment was begun with nafcillin and vancomycin. Over the next several days, despite appropriate antibiotic therapy, he remained febrile (39.8°C). Hematocrit dropped from 35 to 22%, leukocyte count increased from 10,300 to 29,800 mm^3 and the PR interval increased from 0.18 to 0.25 second.

An echocardiogram on the ninth hospital day revealed a large mass within an echo-free space beneath the normal-appearing aortic valve prosthesis (Fig. 5). The patient was taken immediately to surgery where a subvalvular abscess containing a large amount of necrotic debris was found between the noncoronary and left coronary cusps that encroached on the left atrium. It appeared that rupture of the abscess was imminent. There was no involvement of the Hancock prosthesis. The aortic valve prosthesis was replaced with a Björk-Shiley valve and a Dacron patch graft was used to repair the aortic-left ventricular discontinuity left after evacuation of the large valve ring abscess. After an uneventful postoperative course and a normal echocardiogram, he was discharged. He has been seen once since discharge without complaints or abnormal physical or laboratory findings.

Discussion

Echocardiography is the principal noninvasive technique for the diagnosis and follow-up of patients with native or prosthetic valve endocarditis (1–7). Although recognition of a vegetation is the primary indication for echocardiography in these patients, complications of the infective process, including anular dehiscence, leaflet degeneration and regurgitation, can also be diagnosed (1–7). Detection of a valve ring abscess is especially important, because it is usually associated with a higher incidence of serious complications and higher mortality than endocarditis alone (8). The presence of a perivalvular abscess is also associated with an increased rate of complication with valve replacement (10,11).

Incidence of valve ring abscess. Clinical and autopsy studies (12–14) suggest that a perivalvular abscess may complicate native valve endocarditis in up to 30% of patients, especially when it involves the aortic valve. Arnett and Roberts (13) found a valve ring abscess at autopsy in 24 (41%) of 59 patients with aortic valve endocarditis in contrast to only 3 (6%) of 48 patients with mitral valve endocarditis (13). Perivalvular abscesses, however, occur even more frequently when endocarditis affects prosthetic valves. Arnett and Roberts (12) reported in another autopsy

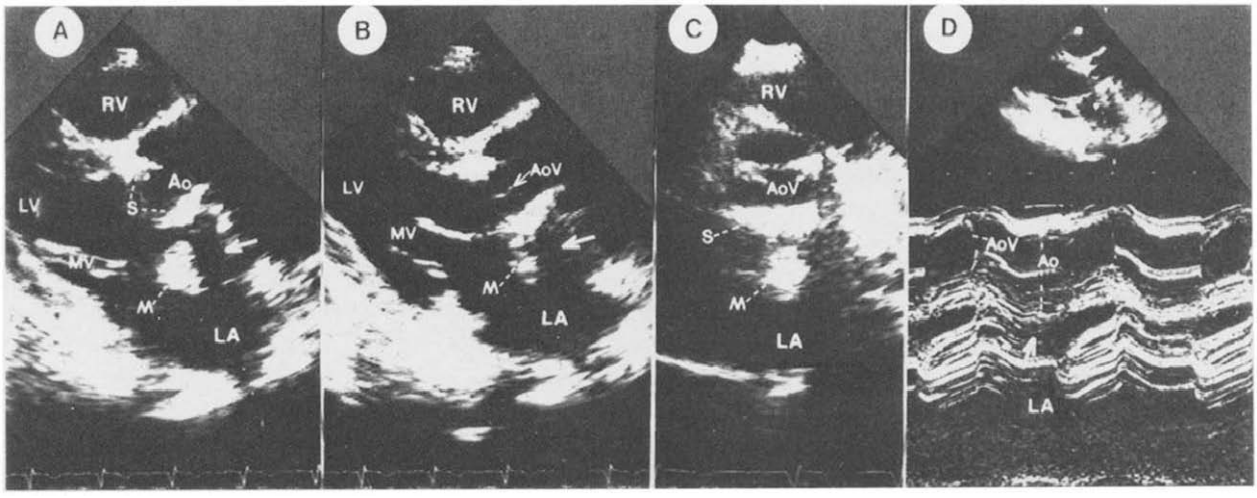

Figure 5. Case 4. Echocardiogram in a patient with a Hancock aortic valve prosthesis. **A** and **B**, Parasternal long-axis views in systole and diastole, respectively, show a mass (M) within a large echo-free space (**arrow**). The mass represents necrotic debris within an "abscess" cavity that is located beneath the aorta (Ao). It appears to bulge into the left atrium (LA). The stents (S) of the prosthesis are clearly seen outlining the aorta. **C**, Parasternal short-axis view shows the mass (M) beneath the posterior stent (S) of the aortic valve (AoV) prosthesis. **D**, M-mode image obtained with the cursor through the prosthesis and mass shows a normal appearing aortic valve (AoV) and a confluence of echoes (**arrow**) representing a mass within a valve ring abscess. Other abbreviations as in Figure 1.

series that all 22 patients with endocarditis involving a rigid frame prosthetic valve (aortic in 15, mitral in 7) had a perivalvular abscess, in contrast to 22 of 74 patients with endocarditis involving a native valve (aortic in 21, mitral in 1). The relatively high reported incidence of perivalvular abscess complicating endocarditis, however, is derived from findings based primarily on surgery and autopsy series. The incidence may be lower in patients who survive and do not require surgery.

Echocardiographic and clinical features of a valve ring abscess. A valve ring (perivalvular) abscess complicating endocarditis may be suggested by a variety of two-dimensional echocardiographic findings. Come and Riley (15) postulated that excessive thickness of the anterior aortic wall may be an early sign of perivalvular infection. Ellis et al. (8) assessed the sensitivity and specificity of a variety of two-dimensional echocardiographic findings in 22 patients with a valve ring abscess and found a high predictive value if one or more of their proposed criteria were present. An echo-free space, however, was identified in only one of their patients.

In our study, valve ring abscess was suspected on two-dimensional echocardiography when an echo-free space was identified in more than one tomographic plane. The parasternal and apical long-axis views were the most reliable images for identifying the abscess cavity. Doppler ultrasound, though only available in one of our patients, may be a useful adjunctive test in patients by identifying paraprosthetic regurgitation before it becomes clinically appar-

Table 2. Summary of 11 Reported Cases of Valve Ring Abscess Diagnosed by Identification of an Echo-Free Cavity on Two-Dimensional Echocardiography

Reference (First Author)	Year	Valve	Organism	Vegetations on Echo	CHF	Regurgitation	Surgery
Mardelli (16)	1978	Aortic	*Enterococcus*	+	+	+	Yes
Wong (17)	1981	Aortic	Negative	+	+	+	Yes
Scanlan (18)	1982	Aortic	*Staphylococcus aureus*	+	+	+	Yes
		Aortic	*Streptococcus viridans*	+	?	+	Yes
		Tricuspid	*Staphylococcus aureus*	+	—	?	No
		Aortic	*Staphylococcus aureus*	+	+	+	Yes
Nakamura (19)	1982	Mitral	*Streptococcus viridans*	+	—	+	Yes
Maloof (20)	1984	Aortic	Negative	+	+	+	Yes
Agatson (21)	1985	Aortic	*Streptococcus*	+	—	—	Yes
Ellis (8)	1985	Aortic	?	+	+	?	?
Vandenbossche (9)	1983	Aortic (prosthesis)	*Salmonella typhimurium*	—	—	+	No

+ = present; — = absent; ? = not reported; CHF = congestive heart failure; Echo = echocardiography.

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ent. Three of our patients had severe aortic regurgitation and congestive heart failure at the time of echocardiography.

Three of our patients (Cases 1, 3 and 4) did not have vegetations visible by echocardiography despite demonstration of an echo-free cavity. This finding is similar to that described by Vandenbossche et al. (9) in a patient with a prosthetic valve, although it is in contrast to the nine previously reported cases with valve ring abscess complicating native valve endocarditis. Our two patients (Cases 1 and 3) who presented without evidence of active endocarditis probably had a valve ring abscess as a sequela of prior episodes of endocarditis, because at surgery each of their abscess cavities contained necrotic debris. Probable explanations for the absence of an active infection include: 1) prior treatment with antibiotic drugs; 2) altered immune status; and 3) infection with nonbacterial organisms.

Review of literature. There have been only 10 other reported cases (9,16–21), in addition to the patient described by Ellis et al. (8) in which a valve ring abscess was suspected by recognition of an echo-free space on two-dimensional echocardiography (Table 2). Ten of these patients had native valve endocarditis (16–21) and only one patient had prosthetic valve endocarditis (9). The aortic valve was involved in 8 of the 10 native valve cases, the mitral valve in 1 and the tricuspid valve in 1. All 10 patients with native valve endocarditis had, in addition to an echo-free space, distinct vegetations visible on the two-dimensional echocardiogram. A regurgitant murmur was noted in 7 of these 10 patients and congestive heart failure was present in 6. Only one patient had no evidence of endocarditis. Two patients, however, did not have positive blood cultures when first seen. One, described by Agatson et al. (21), showed apparent clinical resolution of endocarditis at 4 weeks despite serial echocardiograms that showed enlargement of the echo-free space. At surgery, it appeared that rupture of the abscess into the left atrium was imminent.

The one reported case of a patient with an echo-free space and a prosthetic valve involved a St. Jude Medical prosthesis in the aortic position (9). Evidence of endocarditis was present on admission, but the initial two-dimensional echocardiogram revealed only thickening of the posterior aortic wall. Despite clinical resolution of the infection, an echocardiogram performed 1 week later revealed an echo-free space in the absence of vegetations. Aortic regurgitation was first heard in the third week of hospitalization.

Clinical implications. Visualization of an echo-free space representing a valve ring abscess may be a less rare finding than is suggested by the paucity of published reports. An echo-free cavity was unequivocally documented on the initial echocardiographic examination in only one of our patients. However, a detailed analysis of the videotape in our Case 2 and a repeat echocardiogram by a more experienced echocardiographer in our Case 3 revealed the echo-free spaces. In addition, it is probable that the initial echocardiogram was performed too early in the clinical course, before development of a valve ring abscess, in our Case 4. Repeated examinations may, therefore, be necessary to identify a valve ring abscess even after apparent clinical resolution of the infection.

Congestive heart failure, valvular regurgitation, persistent fever and PR interval prolongation may be the only clinical clues to the presence of a valve ring abscess. Two of our patients and one previously described patient with involvement of a native valve (17) had neither evidence of active endocarditis nor positive blood cultures despite surgical confirmation of a valve ring abscess. In addition, patients with a valve ring abscess may have an echo-free space identified echocardiographically without visible vegetations, as evidenced by three of our patients and the patient with a St. Jude aortic prosthesis reported on by Vandenbossche et al. (9). On the other hand, all of the patients with native valve endocarditis and an echo-free cavity had vegetations identified echocardiographically. Furthermore, some patients may have clinical resolution of their infective process despite echocardiographic evidence of an enlarging echo-free (abscess) space. The value of Doppler ultrasound in the patient with a suspected valve ring abscess remains to be determined because the Doppler study may detect regurgitation in normally functioning prosthetic valves (22).

Conclusions. The identification of an echo-free space on two-dimensional echocardiography may suggest the presence of a valve ring abscess. A valve ring abscess may be found in patients without clinical evidence of endocarditis or valve regurgitation, in the absence of echocardiographically visible vegetations or during resolution of endocarditis. The sensitivity of two-dimensional echocardiography for detecting a valve ring abscess may be improved by repeat examinations and careful review of the study by experienced echocardiographers.

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